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environmental restoration project

A Department of Energy Environmental Cleanup Program

Environmental Restoration Project
Standard Operating Procedure

for:

Well Construction

Los Alamos
NATIONAL LABORATORY
Los Alamos, New Mexico 87545

Revision Log

Revision	*Effective Date*	*Prepared By*	*Description of Changes*	*Affected Pages*
0	05/14/91	A. Stoker	New Procedure	All
1	05/23/97	John Newsom	Revised to current format and process requirements	All
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Well Construction

Table of Contents

Well Construction

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the process of well construction at the Los Alamos National Laboratory (Laboratory) Envrionmental Restoration (ER) Project.

2.0 SCOPE

This SOP is a mandatory document and shall be implemented by all ER Project participants when constructing wells for the ER Project.

Note: Subcontractors performing work under the ER Project's quality program shall follow this SOP for constructing wells or may use their own procedure(s) as long as the substitute meets the requirements prescribed by the ER Project Quality Management Plan, and is approved by the ER Project's Quality Program Project Leader (QPPL) before the commencement of the designated activities.

3.0 TRAINING

3.1 ER Project personnel this SOP are trained by reading the procedure, and the training is documented in accordance with QP-2.2.

3.2 The **Field Team Leader** (FTL) shall monitor the proper implementation of this procedure and ensure that relevant team members have completed all applicable training assignments in accordance with QP-2.2.

4.0 DEFINITIONS

4.1 *Annular space or annulus* — The space between the borehole wall and the well casing, or the space between a casing pipe and a liner pipe.

4.2 *Annular seal* — The material, usually cement grout or bentonite, placed in the space between the borehole wall and the well casing for zone isolation, especially used to prevent surface contamination from entering the borehole.

4.3 *Bentonite/Bentonite annular seal* — A hydrous aluminum silicate (clay) in slurry, powder, granular, or pellet form that, when hydrated, provides an impervious seal between the well casing and the borehole wall. Bentonite may also be used in a 2% to 5% mixture with Portland Type I, TypeII, or Type I/II cement to form a pumpable grout seal that expands as the material hardens.

4.4 *Filter pack* — Sand, gravel, or glass beads that are uniform, clean, and well rounded and generally siliceous that are placed in the annulus of the well, between the borehole wall and the well intake in order to prevent formation material from entering through the well.

4.5 *Grout* — Cement or bentonite mixtures used in sealing boreholes and wells and for zone isolation. Only Portland Type I, TypeII, and Type I/II cement is approved for use at investigative sites.

4.6 *Monitoring well* — Any well or borehole constructed for the purpose of monitoring fluctuations in groundwater levels, quality of groundwater, or the concentration of contaminants in the vadose zone or groundwater.

4.7 *RFI borehole* — A borehole whose purpose is the immediate or short-term determination of contamination conditions at a site, or a borehole used in a corrective action or remediation of a site.

4.8 *Silica Sand* — Washed and sieved sand of a specified size distribution or gradation composed primarily of silica (e.g., quartz).

4.9 *Site-Specific Health and Safety Plan (SSHASP)*—A health and safety plan that is specific to a site or ER-related field activity that has been approved by an ER health and safety representative. This document contains information specific to the project including scope of work, relevant history, descriptions of hazards by activity associated with the project site(s), and techniques for exposure mitigation (e.g., personal protective equipment [PPE]) and hazard mitigation.

4.10 *Tremie pipe* — A small-diameter pipe used to carry sand pack, bentonite, or grouting materials to the bottom of the borehole. Materials are pumped under pressure or poured to the hole bottom through the pipe. The pipe is retracted as the annulus is filled.

4.11 *Turbidity (nephelometric)* — A measure of the intensity of light scattered by sample particulates relative to a standard reference suspension. The range of water turbidity is measured in nephelometric turbidity units (NTU).

4.12 *Vadose zone* — A zone between the ground surface and the water table that contains water below atmospheric pressure and air or gasses at atmospheric pressure. Also known as the zone of aeration or unsaturated zone.

4.13 *Well casing* — A solid piece of pipe, typically steel, stainless steel or polyvinyl chloride (PVC), used to keep a well open in either unconsolidated materials or unstable rock and as a means to contain zone-isolation materials such as cement grout or bentonite.

4.14 *Well screen* — Perforated casing that allows fluids, while minimizing or eliminating sediment into the well.

5.0 BACKGROUND AND PRECAUTIONS

Note: This SOP is to be used in conjunction with an approved SSHASP. Also, consult the SSHASP for information on and use of all PPE.

5.1 A properly constructed well allows access to formation fluids or gases for the collection of samples and for determining *in situ* characteristics. Ideally, the well should not alter the medium that is being sampled.

5.2 The following is a partial list of critical issues involved in well planning, design, and construction:

- preventing the spread of possible contamination;
- selecting soil-boring or rock-coring technique and hole sizes;
- selecting casing and screen materials, including composition and dimensions;
- determining screen-slot size, screen type, and screen interval;
- determining filter pack composition, gradation, and dimensions; and
- choosing a grouting plan.

Refer to the site-specific documents for the location and specifications of the wells to be installed. Wells are generally installed as components of monitoring systems in accordance with Hazardous and Solid Waste Amendments (HSWA) and Environmental Protection Agency (EPA) guidance (EPA 1991).Well construction, development of the wells, collection and measurement of samples, and the documentation of data must be performed as described in this SOP.

The following steps are primarily directed at deep and intermediate depth wells (generally greater than 300' in depth) and are not necessarily requirements for hand borings or shallow boreholes.

5.2.1 Perform a site hydrogeologic examination to estimate key parameters (for example, anticipated aquifer depth and thickness, types of contaminants, geology and grain-size distribution).

5.2.2 Coordinate schedules/actions with the University Technical Representative (UTR) and/or Project Leader and appropriate technical team.

5.2.3 The source(s) of any water used on site must be pre-approved by the **UTR** and/or **Project Leader** before field operations begin. A potable, nonchlorinated source is preferred, and the source is to be documented in the daily logs. At his discretion, the **UTR** may require analytical samples be collected of the water source.

5.2.4 Any use of solvents, glues, or cleaners is prohibited unless approved in writing by the **UTR** and/or **Project Leader**. If official permission is

granted for their use, describe the material and include the manufacturer and type (specification)(MSDS sheet must also be included). The on-site use of nonenvironmentally safe and/or unapproved pipe-dope, grease, soap, or oil is also prohibited for any purpose with the exception of machinery fuel and lubricants

5.2.5 Monitor the borehole opening and the breathing zone as necessary according to the appropriate ER SOPs and SSHASP. Perform readings as often as necessary to ensure the safety of workers, and record all measurements on the appropriate data-collection forms.

6.0 RESPONSIBLE PERSONNEL

The following personnel are responsible for activities identified in this procedure.

6.1 ER Project Personnel

6.2 Driller

6.3 Field Team Leader

6.4 Site Geologist

6.5 University Techncial Representative

7.0 EQUIPMENT

Descriptions of commonly used pieces of equipment are listed below.

7.1 Well-Construction Supplies (Some of these items are suggestions only, and the list is not all-inclusive.)

- Silica sand (i.e. 30/70, 20/40, and 8/12 grain size)
- Cement—Portland Type I, Type II or Type I/II only
- Approved water supply, preferably untreated
- Well casing, screen, cap, and bottom plug for each well, as required
- Mechanical casing centralizers, if required
- Bentonite pellets, crushed bentonite, or bentonite grout
- A 5-ft length of protective steel casing—black iron or galvanized—6-, 8-, or 10-in. in diameter, according to needs
- Guard posts
- Locking cap
- Padlocks

7.2 Well-Construction Equipment

- Drill rig and accompanying equipment (augers, drill rods, casing, samplers, etc.)

- Tremie pipe
- Grout-mixing and pressure-pumping unit
- Support equipment for maintaining 24 hr/day operation

8.0 PROCEDURE

Note: ER Project personnel may produce paper copies of this procedure printed from the controlled-document electronic file located at http://erinternal.lanl.gov/home_links/Library_proc.htm. However, it is their responsibility to ensure that they are trained to and utilizing the current version of this procedure. The author may be contacted if text is unclear. Contact the Document Control Coordinator if the author cannot be located.

Note: Deviations from SOPs are made in accordance with QP-4.2, Standard Operating Procedure Development and documented in accordance with QP-5.7, Notebook Documentation for Environmental Restoration Techncial Activities.

8.1 General Well Installation Record Keeping

8.1.1 Record all field measurements and comments on the Borehole/Well Completion Information form (Attachment A) or the Borehole/Well Construction Field Data Log form (Attachment B). Fill out the forms as described in the completion instructions included with each form. A Fact Summary Sheet (Attachment C) should also be completed.

8.1.1.1 The **FTL** shall consult with the UTR and/or Project Leader before modifying an existing well design. Any modification must be recorded in the Borehole/Well Construction Field Data Log form (Attachment B), the Fact Summary Sheet (Attachment C) and the Daily Activity Log form (Attachment E in ER-SOP-1.04), or a field notebook.

8.1.2 Record pertinent information on the Borehole/Well Completion Information form (Attachment A) and the Fact Summary Sheet (Attachment C). At a minimum, record boring/well identification number, location of boring (coordinates if available), nominal hole diameter and depth at which diameter changes, screen location, backfill, seals, grout, cave-in, centralizers, and the height of the riser above the ground surface. Record the actual composition of the grout, seals, and backfill on each Borehole/Well Construction Field Data Log form (Attachment B). Include the screen slot size (in inches), slot configuration, and screen manufacturer. Include the protective casing detail on all well sketches.

Typical well construction features for single screen and multi-screen completions are shown in Attachments D and E. When installed as a piezometer, well point (for water levels only), or gas-vapor monitor, the well configuration may vary significantly from these drawings. After well development is complete, indicate the static water level on the well-construction diagram.

8.2 Sand Pack

A sand pack helps ensure continuous flow capability from the natural formation to the well bore. The following is a list of instructions for using a sand pack, if required.

8.2.1 The minimum annular distance between well screen and the borehole wall is 2 inches for ER Project wells.

8.2.2 The specifications of the proposed sand-pack material should be approved by the **FTL** before use. Use well-sorted (poorly graded) and rounded sand that is clean, inert, and siliceous and compatible with the screen slot size in-use.

8.2.3 The average grain size of the sand is based on the grain-size distribution of the medium being monitored in the screened formation. Use sand that has a gradation that will allow less than 10% of filter-pack material to pass through the screen slots (insert Reference).

8.2.4 Record the filter-pack size, the company from which it was purchased, and the lot number (if available) for each installation. Be prepared to take an airtight pint size sample of filter pack material and furnished to the UTR upon request for each well to serve as a quality control.

8.2.5 Fill the annulus between the well screen and borehole wall with silica sand to a height 5 ft above the screened interval and 5 ft below the screen if above a bentonite seal or as specified in applicable Title I or II drawings if required. For wells greater than 30 ft in depth, a tremie pipe will be used to place the materials.

Note: For intermediate and deep wells, go to Sections 7.6 - 7.9 for the complete procedure to place the dry product backfill materials.

8.2.6 Ascertain the depth of the top of the sand with a measuring device with an accuracy within 0.5' and verify the thickness of the sand pack. Measurements must be repeatable.If necessary, add more sand to bring the top of the sand pack to the proper elevation.

8.2.7 Under no circumstances should the sand pack extend into any aquifer other than the one to be monitored. In most cases, the well design can be modified to allow for a sufficient sand pack without the threat of cross flow between producing zones.

8.2.8 If specified in the project documents, partial development of the sand pack may be required (to help settle sand pack) before installation of bentonite seal and grout.

8.2.9 In the event that a predominantly fine-grained, water-bearing unit is encountered, it may be desirable to construct a monitor well that uses a factory-manufactured screen and filter prepack assembly. Various sand-pack gradations are available. The prepacked screen subassembly is attached to the solid well casing (riser) in the same manner as a conventional screen. The fine-grained formation materials are allowed to collapse against the prepacked well screen. Prepacked well screens have larger OD's which must be considered when calculating backfill.

8.2.10 Centralizers will be placed above and below each screen or as specified in Title I design documents. Generally, no less than one every 50 ft for the uniform and complete annular filling by granular backfill, seal, and grout materials. Centralizers may be required at 10-ft intervals or less when installing angle holes. In some cases, such as very shallow wells and where tremie-pipe placement of materials is done through pipes or augers, the spacing of centralizers can be expanded or eliminated entirely. Fasten centralizers to the well casing and radially space them at 120° or 90° intervals.

8.3 Intermediate Bentonite Seal

The following steps outline the use of an intermediate bentonite seal from the top of the sand pack to 2 ft above.

8.3.1 Before placing the bentonite seal, be sure the filter pack has settled by measuring the depth of the top of the sand with the tremie pipe or a measuring device with an accuracy within 0.5'. The sand pack should rise to a depth of 5 ft above the top of the screen.

Note: For intermediate and deep wells, go to Section 7.9 for procedures on sounding backfill depths.

8.3.2 In media that will not maintain an open hole, leave the casing or the hollow-stem augers in the hole during filter-pack placement and bentonite-seal placement to the extent practical. Maintain the bentonite in the casing/auger a small distance (1 to 2 ft) above the bottom of the casing/auger for even placement, as the casing/augers are removed. Special attention should be given to the amount of fill material if this procedure is followed due to the risk of bridging in saturated conditions.

Note: For intermediate and deep wells, go to Section 7.7 for the procedure on drill casing retraction during backfill placement.

8.3.3 Visually check the condition of the bentonite backfill material before pumping it into the hole by pumping a sample into a bucket. Retract the tremie pipe 3 ft from the top of the sand pack and begin pumping.

8.3.4 Place a bentonite-chip or -pellet seal above the sand pack and below the annular well seal to prevent infiltration of cement into the filter pack and the well. Hydrate the bentonite seal and wait a minimum of 4 hrs before adding a slurry grout.

Note: Use bentonite chips, bentonite pellets, or crushed, granular bentonite. The pellets should have a minimum purity of 90% montmorilonite clay and a minimum dry bulk density of 75 lb/ft^3. No bentonite will be placed into the well bore—place a cap over the top of the well casing before pouring the bentonite pellets.

8.3.5 In special circumstances, an open borehole may be drilled to a depth below where the screen is set. If grout is used to seal off a lower aquifer or as backfill up to the proper level, place a bentonite seal above the grout and hydrate for 4 hrs before the casing, screen, and sand pack are introduced. Allow the grout to set up for a minimum of 24 hrs before placing the bentonite seal. Place 5 ft of sand pack between this grout and the well screen. Place the bentonite seal in the borehole as described below. The minimum width for the annular well seal (between casing and borehole) is 2 in. for ER Project wells.

8.3.6 For wells that are 30 ft or less in depth:

8.3.6.1 Pour the bentonite directly down the annulus. Pour the pellets from different points around the casing to ensure even an application. A tremie pipe may be used to redistribute and level the top of the seal.

8.3.6.2 Fill the annulus between the well casing and borehole above the filter pack with a bentonite seal at least 2 ft thick (vertically); hydrate and wait 12 hrs.

8.3.7 For wells deeper than 30 ft:

The bentonite backfill material can be pumped or poured through a tremie pipe. The **FTL** shall determine the method after evaluating the condition of the borehole walls. If there are no centralizers in the upper portions of the casing, manipulate the casing to prevent pellets from hanging up in the narrow annulus and to allow them to settle to the bottom as rapidly as possible.

Note: For intermediate and deep wells, go to Sections 7.6 - 7.9 for the complete procedure to place the dry product backfill materials.

8.3.8 Measure the distance to the top of the seal with an acceptable measuring device to verify that the proper thickness of seal has been placed in the annulus.

Note: For intermediate and deep wells, go to Section 7.9 for the complete procedure on sounding the depth of backfill materials.

8.3.9 Until the proper thickness of bentonite has been placed in the well annulus, repeat the application and verification.

8.4 Annular Well Seal

8.4.1 For placement of dry product annular backfill materials in intermediate and deep wells, go to Sections 7.6 - 7.9 for complete backfilling procedures.

8.4.2 If a cement-grout annular seal is to be installed, use only Portland Type I, Type II or Type I/II cement. The grout must be mixed thoroughly with 2% to 5% bentonite powder to produce a nonshrinking seal. The cement must be mechanically mixed thoroughly before it is pumped into the borehole.

8.4.3 If a slurry of bentonite is used as an annular seal, prepare the slurry by mixing powdered or granular bentonite with pre-approved potable water according to manufacturer specifications. The slurry should be of sufficiently high specific gravity and viscosity to prevent movement of the overlying grout into the saturated zone. Pellets may be added to solidify the surface of the bentonite slurry in order to prevent cement intrusion.

8.4.4 In some cases a dry mixture of fine sand, silica flour, and bentonite powder or a mixture of cuttings, sandy clay, or tight soil may be used where the fill material will have less permeability than the formation. In general the cuttings cannot be easily emplaced because of screening and/or compacting problems. Cuttings mixed with dry bentonite can be used for abandonment purposes.

8.5 Surface Well Seal Minimum Depth and Width

The minimum depth of an annular well seal above the fill is 10 ft. The minimum width of the annular seal is 2 in. Allow a minimum of 12 hrs (HSWA requirement) after a bentonite-slurry seal has been placed, then place cement grout from the top of the bentonite seal to the surface. Use grouts as specified in project documents. Place grout in the annulus of the wells as described below.

8.5.1 Fill the annulus between the well casing and borehole wall with cement grout.

8.5.2 On all wells 30 ft deep or deeper, pump the cement grout through the tremie pipe to the bottom of the open annulus until undiluted grout flows from the annulus at the ground surface.

Note: The cement grout should consist of a mix of cement (Portland Type I, Type II, or Type I/II) and 2% to 5% bentonite mix. Use only grout mixed with pre-approved water.

8.5.3 When drilling in materials that will not maintain an open hole, leave the hollow-stem auger or temporary casing in the hole during grouting to the extent practical. Remove them as the level of the grout rises above the bottom of the auger.

8.5.4 If necessary, add more grout to compensate for the removed casing or auger and tremie pipe and to ensure that the top of the grout is at or above the ground surface.

8.5.5 The protective casing should now be placed over the well casing.

8.5.6 After the grout has set (about 24 hrs), fill any depression in the grout caused by settlement with a grout mix similar to that previously described.

8.6 Placement of Dry Product Annular Backfill Materials (Intermediate and Deep Wells)

8.6.1 The **driller** shall place all annular fill materials (dry products only) through a tremie pipe maintaining a 10-ft minimum buffer between the targeted backfill depth and the bottom of the tremie pipe.

8.6.2 Both the **driller** and the **site geologist** shall in accordance with QP-5.7, Notebook Documentation for Environmental Restoration Technical Activities, record in a logbook accurate tallies of tremie pipe and drill casing to ensure that the exact depths are known at all times.

8.6.3 Both the **driller** and the **site geologist** shall, on a scheduled basis, compare their tremie pipe and drill casing tallies to ensure they are in agreement. In the event they are not in agreement, backfilling activities will be suspended until an acceptable resolution is attained and the depths can be verified to the satisfaction of both parties.

8.6.4 The **driller** shall use potable water (municipal supply) as a transport fluid to carry dry materials such as bentonite pellets and silica sand down the tremie to the desired depth. A polymer such as EZ-MUD, approved by the **UTR**, may be added to the transport fluid to delay hydration of bentonite chips or pellets in deeper applications. This will reduce the potential for swelling within the tremie pipe which commonly results in plugging.

8.6.5 If a polymer solution is used, the **driller** must flush the tremie with one volume of the tremie rodwith clear water prior to filter pack sand emplacement

8.6.6 The **driller** shall record in a field notebook the quantities of water and additives used during the placement of annular backfill material.

8.6.7 The **driller** shall use silica sand that meets the specifications in the Title II design drawing (typically fine-grained 30/70 and 20/40 grade) for filter packs and transition zones between filter packs and bentonite seals.

8.6.8 Fine-grained sands (30/70, 20/40 grade) shall be allowed to settle for 15 to 30 minutes after the pour is completed before sounding the depth.

8.6.9 If the sand level is low, the **driller** shall allow an additional 15 to 30 minutes for the sand to settle and then re-sound the sand level.

Note: Sands with grades greaterthan 20/40 can be expected to settle more rapidly and typically can be measured immediately after emplacement.

8.7 Drill Casing Retraction During Backfill Operations (For Intermediate and Deep Wells)

8.7.1 The **driller** shall retract the drill casing in stages as backfill materials are emplaced to avoid borehole collapse in potentially unstable formations.

8.7.2 The **driller** shall maintain a 10-ft minimum buffer between the targeted backfill depth and the bottom of the drill casing to prevent backfill from getting between well casing and drill casing. This may result in sand locking the casings or smearing bentonite across well screens

8.7.3 The **driller** shall determine the length of drill casing to be retracted between pours based on borehole stability, the size of the batch to be poured, and casing stickup in the rig table. The **site geologist** shall provide borehole stability information to the driller based on site stratigraphic,geophysical logging data, and video logs if available. For large intervals of backfill in stable formations, it may be acceptable to pull 100 or more feet of casing followed by one large or several small batches of backfill. In unstable formations, casing should be retracted at shorter intervals of 20 to 40 ft, followed by small batches of backfill, to minimize borehole caving into the annular space. Cave-ins may result in damage to the well casing and

screens, displacement of annular fill materials, and may compromise the integrity of annular seals.

8.8 Volume Calculations

8.8.1 Both the **driller** and the **site geologist** shall make volume calculations of all materials introduced into the borehole prior to emplacement. Backfilling should not proceed until the calculated volumes are in agreement.

8.8.2 Both the **driller** and the **site geologist** shall ensure that the calculated volume for the interval to be filled is not exceeded regardless of the character of the formation.

8.8.3 The **driller** shall take extreme care when backfilling with bentonite below a screened section of the well casing to prevent impact to the screen.

8.8.4 The **driller** shall ensure the target depth for standard batches of bentonite are at a minimum 20 ft below the bottom of the screen. The **driller** shall ensure that the remainder of the bentonite interval below the screen is poured in small batches calculated to raise the level in the annulus by 2 to 3 ft per batch.

8.8.5 The **driller** shall sound (measure) the bentonite after each batch until the desired depth is reached. The bentonite shall be allowed to hydrate for a minimum of 30 minutes before installing silica sand.

Note: The volume of the annular space can be determined by subtracting the volume displaced by the well casing (outside diameter) from the total borehole volume. The borehole volume and casing displacement is determined using drilling reference tables or the formula for the volume of a cylinder ($V=\pi r^2 h$). Annular space volume (V_a) is determined using $V_a=V_t-V_c$; where a=annulus, t=total, and c=casing.

8.8.6 The **driller** or the **site geologist** shall perform calculations for each batch. All calculations shall be recorded in the field logbook.

8.9 Sounding Backfill Depths (For Intermediate and Deep Wells)

8.9.1 The **driller** shall sound the depth to the top of the fill material using a mechanical (weighted tape/wire line) or electronic sounding device. The **site geologist** shall oversee and concur with each measurement before recording the depth in the logbook and Title II drawing. The sounding line shall be run through a sheave suspended over the borehole and lowered through the tremie pipe. Care should be taken to avoid entanglement of the sounding line in the well casing centralizers. The **driller** and **site geologist** shall maintain

cognizance of centralizer locations relative to the tremie pipe at all times.

8.9.2 If a mechanical sounding line is used (weighted tape or wire line), the **driller** will carefully monitor the tension on the wire or tape as the weight nears the depth where the fill is calculated to be. When an electronic sounder is used, the **driller** shall carefully monitor the cable-counter and slow the sounder winch as it approaches the calculated depth of the fill.

8.9.3 Once the sounding device tags bottom, the **driller** will verify the measurement by repeating the measurement process two times with the same result, or within five tenths of a foot (+/-0.5 ft). The **site geologist** shall then record the confirmed measurement in the field logbook to the nearest tenth of a foot (0.1-ft).

Note: Measurements read from a cable counter or graduated tape must be adjusted to account for the length of the weight on the end of the wire or tape. The height of the tremie pipe stickup (above ground level) must be subtracted from the each measurement when referencing depths below ground level.

8.9.4 In the event that the calculated depth and the measured depth are significantly different, the **driller** and **site geologist** shall evaluate the difference and resolve any nonconformance(s). The **driller** and **site geologist** shall review the casing and centralizer configuration in the Title II well design drawing to ensure that a well-casing centralizer is not inadvertently being tagged. If the fill is lower than expected, the geophysical logs, the video logs, and the drillers logs shall be reviewed to determine if voids or fractures are present in the subject interval.

8.9.4.1 If the nonconformance renders the condition of the well unacceptable or indeterminate, the nonconformance shall be resolved in accordance with QP-3.4, Managing Nonconformances, Deficiencies and Corrective Actions before continuing backfill operations.

8.10 Installing Protective Casing Around All Monitor Wells

The minimum elements in the protection design include the following:

8.10.1 The protective steel casing and locking cap should be weatherproof. The locking cap should be secured to the casing by padlocks.

8.10.2 Set the protective casing (5-ft minimum length) so that the top of the pipe is about 1.5 to 3 ft above the ground surface and grout it in place as shown in Attachments D and E.

8.10.3 Use 8-in.-diameter pipe for 4-in. wells,6-in.-diameter pipe for2-in. wells, and 10-in diameter pipe for 5-in. wells (depending on approved borehole size). A drain hole near ground level that is 0.5 in. in diameter is permitted.

8.10.4 Mark the location ID on the inside and outside of the cover with indelible ink, metal punch lettering kit, or by writing with an arc welding machine/rod.

8.10.5 Form and pour the concrete protective pad around the protective steel casing. Pad dimensions will not be less than 2 ft × 2 ft × 0.5 ft. The concrete pad should be sloped away from the casing for positive drainage. The standard regional well pad configuration and design is shown in Attachment E. The brass monument shall be placed into the concrete in the northwest corner of the pad, approximately 12 inches from the edges of the concrete. Location and elevation coordinates and the FIMAD location I.D. number shall be clearly imprinted in the monument.

8.10.6 In addition to the protective casing, the installation of guard posts is recommended in areas where vehicle traffic might pose a hazard. The guard posts shown in Attachment E consist of steel posts that are at least 3 in. in diameter. Four guard posts are radially located around each well vault and placed at least 2 ft below the ground's surface. Each post will have a minimum of 4 ft above the ground surface and, in cases where the borehole/well is surrounded by high vegetation, will have a flag attached for greater visibility. Each post should be cemented inside of a hole that has a minimum diameter of 6 in.

8.11 Recording Well Construction Details

8.11.1 The **driller** and **site geologist** shall keep an accurate record of all well construction materials in the site logbook. The records shall include at minimum the following:

- type of material,
- manufacturer name and address,
- batch or control number,
- calculations showing estimated volume of material placed during each lift
- number of packages of each product used in each interval/lift,
- size of individual packages,
- volume and composition of transport fluids,

- condition of materials and packaging; and
- any other potentially valuable information.

8.11.2 After completing a unit of backfill (i.e. filterpack interval), the **site geologist** shall make and record a comparison between the calculated and actual volumes of material required in the field logbook. Methods of installation shall also be described and recorded in the field logbook.

8.12 Documenting the Final Well Configuration

8.12.1 The **site geologist** shall record the final measured depth of each complete unit of annular fill on the most recently approved Title II well design drawing and in the field logbook.

8.12.2 The **site geologist** shall record all observations made during backfilling and depth sounding in the field logbook.

8.12.3 Observations should include at a minimum the following:

- differences in the design-specified and as-built fill levels of each unit of annular fill,
- anomalous depth measurements,
- an evaluation of any problems encountered and the final resolutions, and
- any other information or observations that may be useful in assessing the quality of the installation.

8.13 Development

Refer to ER SOP 5.02 Well Development for procedure.

8.14 Abandonment

Refer to ER-SOP-5.03 Monitor Well and RFI Borehole Abandonment forguidance.

8.15 Post-Operation Activities

8.15.1 Ensure all equipment is accounted for and decontaminate equipment (according to directions in ER-SOP-1.08) where necessary. Return equipment to the equipment manager and report incidents of malfunction or damage.

8.15.2 Make sure all wells are properly labeled and the location ID is readily visible on the protective casing and the brass monument.

8.15.3 Ensure that well surveying as per ER-SOP-3.01 for horizontal control and datum determination are completed and that the necessary

information is entered on the Borehole/Well Completion Information form (Attachment A).

8.16 Perform Lessons Learned

During the performance of work, **ER Project personnel** shall identify, document, and submit lessons learned, as appropriate in accordance with QP-3.2, Lessons Learned, located at: http://erinternal.lanl.gov/home_links/Library_proc.htm.

9.0 REFERENCES

ER Project personnel using this procedure should become familiar with the contents of the following documents to properly implement this SOP.

- ER Project Quality Management Plan located at. http://erinternal.lanl.gov/home_links/Library_proc.htm
- QP-2.2, Personnel Orientation and Training
- qp-3.2, Lessons Learned
- QP-3.4, Managing Nonconformances, Deficiencies and Corrective Actions
- QP-4.2, Standard Operating Procedure Development
- QP-4.4, Record Transmittal to the Records Processing Facility) to the Records Processing Facility.
- ER-SOP-1.04, Sample Control and Field Documentation
- ER-SOP-1.08, Field Decontamination of Drilling and Sampling Equipment
- ER-SOP-3.01, Land Surveying Procedures
- ER-SOP-4.01, Drilling Methods and Drill Site Management
- ER-SOP-5.02, Well Development
- ER-SOP-5.03, Monitoring Well and RFI Borehole Abandonment
- EPA, “Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells,” (Environmental Monitoring Systems Laboratory, Office of Research and Development, 1991).

10.0 RECORDS

The **FTL** is responsible for submitting the following records (processed in accordance with QP-4.4, Record Transmittal to the Records Processing Facility) to the Records Processing Facility.

10.1 Daily Activity Log forms (Attachment A in ER-SOP-1.04) or a field notebook

10.2 Completed Borehole/Well Completion Information form (Attachment A)

10.3 Completed Borehole/Well Construction Field Data Log form (Attachment B)

10.4 Well construction calculations (as applicable)

10.5 Completed Logbook

10.6 Red lined Title II Design Drawing (as applicable)

10.7 If other records are generated, they are to be paginated and attached to the records in the record package.

11.0 ATTACHMENTS

All forms can be located at http://erinternal.lanl.gov/Quality/er/forms.asp

Attachment A: Borehole/Well Completion Information (form and completion instructions) (3 pages)

Attachment B: Borehole/Well Construction Field Data Log (form and completion instructions) (2 pages)

Attachment C: Fact Summary Sheet (1 page)

Attachment D: Typical Construction of a Single Screen Monitoring Well at Los Alamos (1 page)

Attachment E: Surface Completion Details (1 page)

Borehole / Well Completion Information

Date/Time: _____ Sheet ____ of ____

Technical Area _____ Focus Area _____ Site Work Plan: _____

Field Team Leader: _____
(Print name and title, then sign)

Installer: _____
(Print name and title, then sign)

Borehole / Well Construction Information

Borehole ID: _____
Drilling Method: _____
Drilling Fluids Used: _____
Estimated Amounts: _____
Casing Material(s): _____
_____

Surface Seal Material: _____
Annular Seal Material: _____
Filter Pack Mesh Size: _____
Filter Pack Material: _____
Screen Material: _____
Screen Slot Size: _____

Well Type

_____ Monitoring
_____ Treatment
_____ Other (describe) _____
_____

Source

_____ Regional Aquifer _____ Alluvial
_____ Perched(Intermediate) _____ Vadose
_____ Other (describe) _____
_____

Completed Borehole / Well Information

Borehole Diameter: _____
Total Depth: _____
Casing Diameter: _____
Casing Length: _____

Surface Seal Length: _____
Annular Seal Length: _____
Filter Pack Length: _____
Screen Length: _____
Blank Length: _____

ER-SOP-5.01

Los Alamos
Environmental Restoration Project

Instructions for Completing a Borehole / Well Completion Information Form

Use an indelible dark-ink pen. Make an entry in each blank. For entry blanks for which no data are obtained (except in Comments section), enter “UNK” for unknown, “N/A” for not applicable, or “ND” for not done, as appropriate. To change an entry, draw a single line through it, add the correct information above it, and date and initial the change. For all forms, complete the following information:

Header Information:

1. Date/Time—The date and time when the measurement was made, in the following formats: DD-MMM-YY (e.g., 01-JAN-91) and the 24-hr clock time (0837 for 8:37 a.m. and 1912 for 7:12 p.m.).
2. Sheet Number—Number all the sheets that are used for this activity, by day or by some practical unit.
3. Technical Area (TA)—Two-digit number which indicates the TA in which the activity is being performed.
4. Focus Area—Indicate the Focus Area in which the activity is being performed.
5. Site Work Plan—Title of plan, as applicable.
6. Field Team Leader— Print name and title, then sign.
7. Installer—The driller or installer and affiliation. Print name and title, then sign.

Borehole / Well Construction Information:

1. Borehole ID—The unique number that identifies the borehole.
2. Drilling Method—The method of drilling used to complete the borehole.
3. Drilling Fluids Used—The type of drilling fluids or mud used during drilling, if any.
4. Estimated Amounts—The amount of drilling fluids or mud expended or lost during drilling.
5. Casing Material(s)—The composition of the borehole casing or casings used.
6. Surface Seal Material—Type or composition of material used for surface sealing.
7. Annular Seal Material—The type or composition of material used to seal the annular spacing between the borehole and the casing.
8. Filter Pack Mesh Size—The mesh size or grain size of filter pack.
9. Filter Pack Material—Composition of filter pack material.
10. Screen Material—The material or composition of the screen.
11. Screen Slot Size—Size of slots used for screen.

Well Type:

The purpose or type of well.

Source:

Flow Relationship—The type of aquifer or well relationship to aquifer, if any.

Completed Borehole / Well Information:

Measurements are in feet except where noted.

1. Borehole Diameter—Outside diameter of borehole (in inches).
2. Total Depth—The total depth of borehole.
3. Casing Diameter—Outside diameter of casing (in inches).
4. Casing Length—Total length of casing.
5. Surface Seal Length—Length of surface seal.
6. Annular Seal Length—Length of annular seal.
7. Filter Pack Length—Length of filter pack area.
8. Screen Length—Length of slotted screen.
9. Blank Length—Distance between bottom of screen and bottom of casing.

Borehole / Well Construction Field Data Log

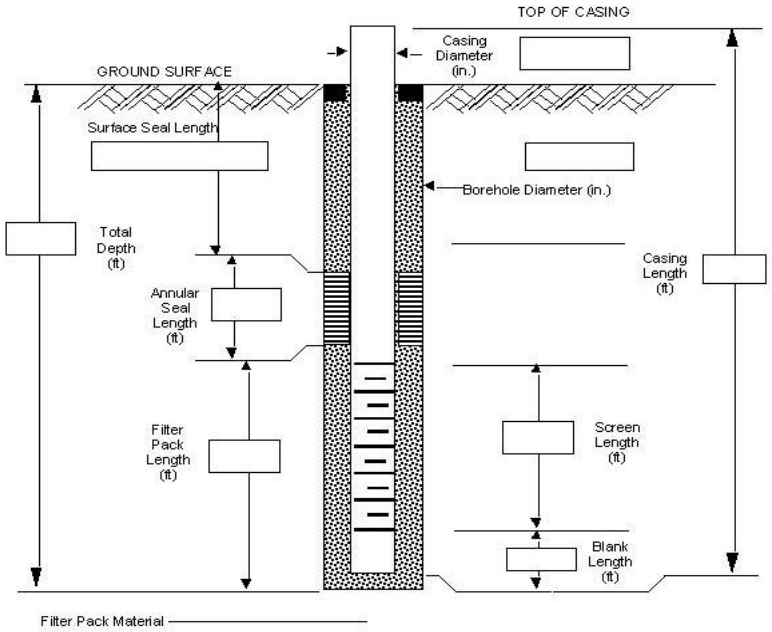
Date/Time: _____ Borehole ID: _____

Technical Area _____ Focus Area _____

Site Work Plan: _____

Field Team Leader: _____
(Print name and title, then sign)

Installer:_____
(Print name and title, then sign)



Comments: _____

_____

_____

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ER-SOP-5.01

Los Alamos
Environmental Restoration Project

Instructions for Completing a Borehole / Well Construction Field Data Log Form

Use an indelible dark-ink pen. Make an entry in each blank. For entry blanks for which no data are obtained (except in Comments section), enter “UNK” for unknown, “N/A” for not applicable, or “ND” for not done, as appropriate. To change an entry, draw a single line through it, add the correct information above it, and date and initial the change. For all forms, complete the following information:

Header Information:

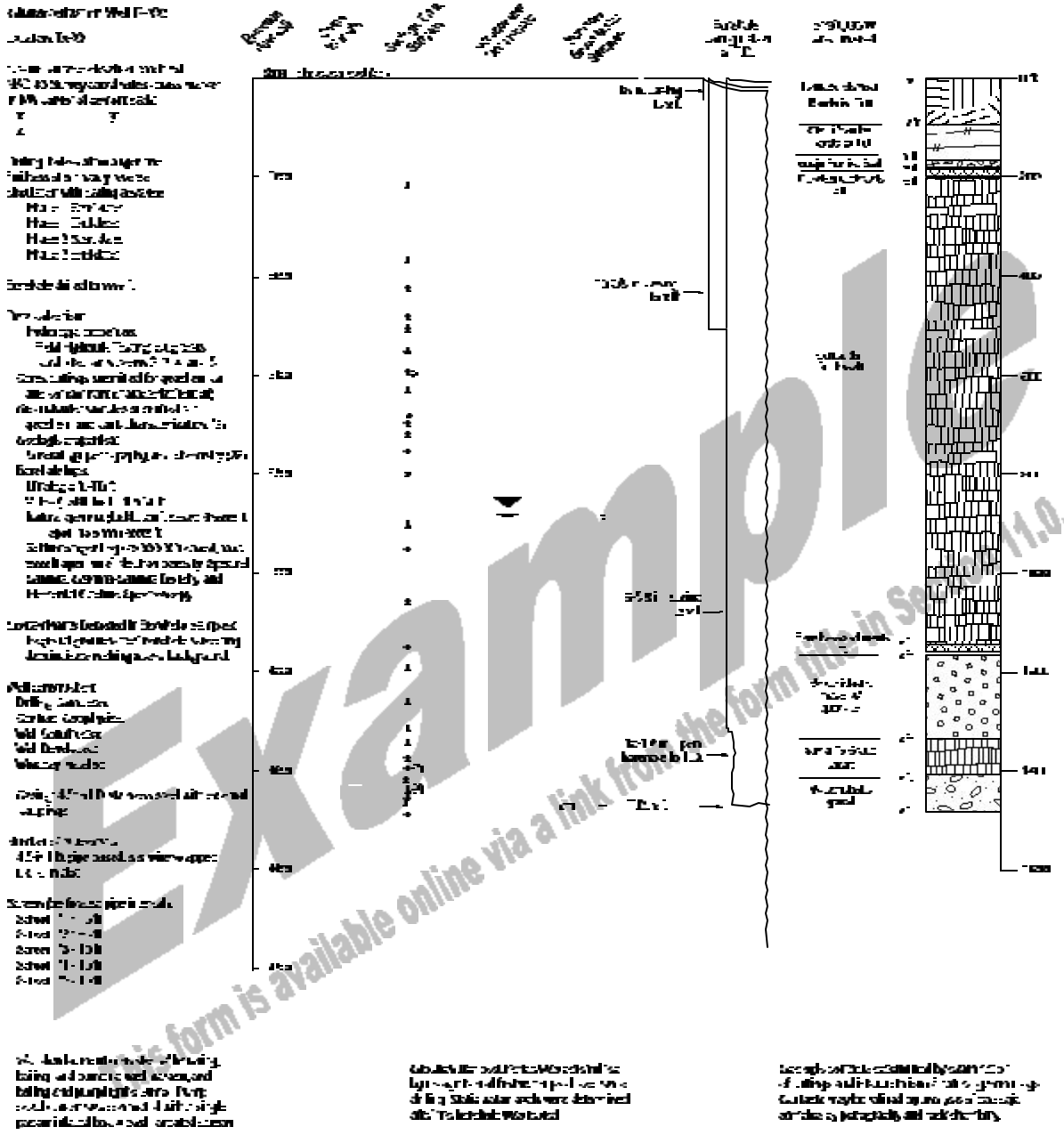
1. Date/Time—The date and time when the measurement was made, in the following formats: DD-MMM-YY (e.g., 01-JAN-91) and the 24-hr clock time (0837 for 8:37 a.m. and 1912 for 7:12 p.m.).
2. Borehole ID—The unique number that identifies the borehole.
3. Technical Area (TA)—Two-digit number which indicates the TA in which the activity is being performed.
4. Focus Area—Indicate the Focus Area in which the activity is being performed.
5. Site Work Plan—Title of plan.
6. Field Team Leader— Print name and title, then sign.
7. Installer—The driller or installer and affiliation. Print name and title, then sign.

Completed Borehole / Well Information:

Measurements are in feet except where noted.

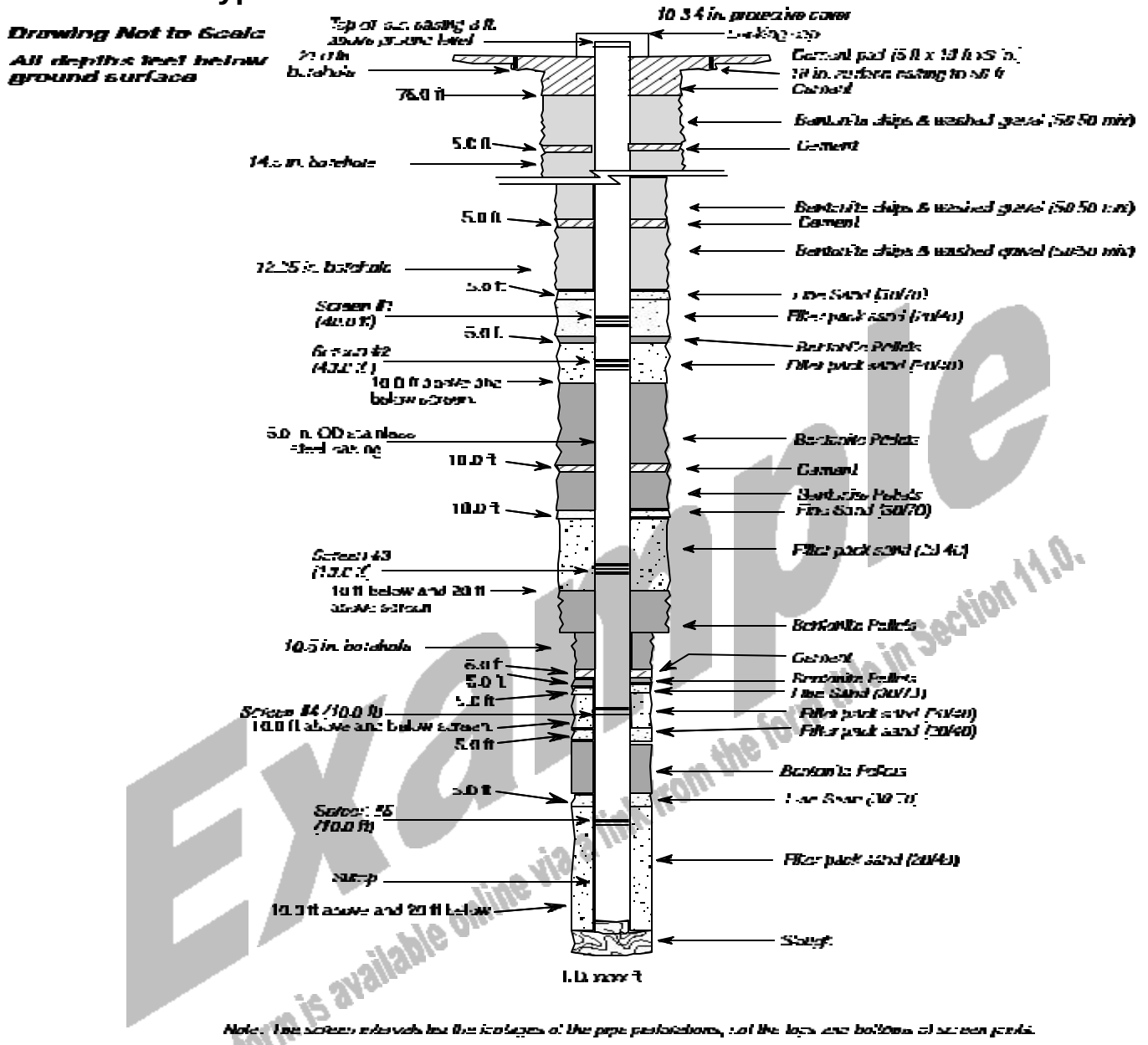
1. Borehole Diameter—Outside diameter of borehole (in inches).
2. Total Depth—The total depth of borehole.
3. Casing Diameter—Outside diameter of casing (in inches).
4. Casing Length—Total length of casing.
5. Surface Seal Length—Length of surface seal.
6. Annular Seal Length—Length of annular seal.
7. Filter Pack Length—Length of filter pack area.
8. Screen Length—Length of slotted screen.
9. Blank Length—Distance between bottom of screen and bottom of casing.
10. Filter Pack Material—Composition of filter pack material.

Fact Summary Sheet



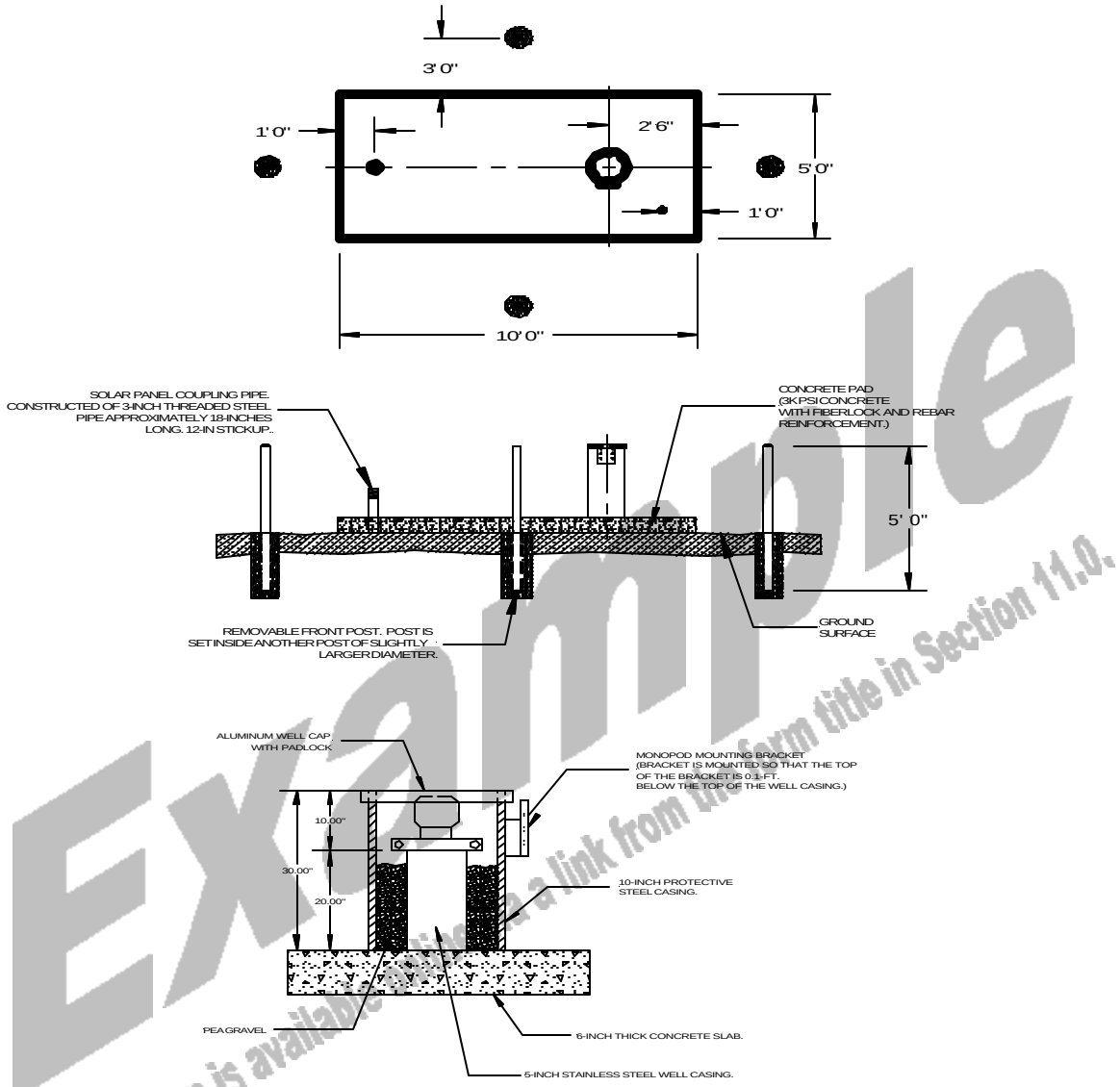
Example of construction, stratigraphic, and hydrologic information for Hydrogeologic Workplan characterization well R-xx.

Typical Construction of a Multi-screen Monitor Well



ER-SOP-5.01	Los Alamos Environmental Restoration Project

SURFACE COMPLETION DETAILS FOR ALL REGIONAL WELLS NOT REQUIRING A PROTECTIVE VAULT.



NOTES:

1. USE REINFORCED STEEL REBAR WITH CROSS TIES AND CLIPS WITH NYLON FIBER ADDED TO THE MIX FOR INCREASED STRENGTH.
2. SPOT-WELD THE REBAR TO THE PROTECTIVE CASING IN FOUR (4) LOCATIONS WHERE THEY ARE IN CONTACT.
3. CURE THE CONCRETE PAD SO AS TO MINIMIZE THE POTENTIAL FOR CRACKING.
4. CROWN THE PAD TO PROMOTE DRAINAGE AWAY FROM THE WELL HEAD.
5. THIS TYPE OF SURFACE COMPLETION IS FOR ALL REGIONAL WELLS THAT WILL NOT REQUIRE A CONCRETE VAULT CONTAINMENT STRUCTURE.